CLAIMS

1. A bistable molecular switch having a highly conjugated first state and a less conjugated second state such that application of an electric field reversibly switches the molecular switch from the first state to the second state, said molecular switch comprising a hydrophobic moiety and a hydrophilic moiety.

2. The molecular switch of claim 1, further comprising at least one rotor having a donor group and an acceptor group, each of the donor and the acceptor groups being operably connected to the rotor to cause switching upon application of an electric field, said donor group having a lower electronegativity than the acceptor group.

3. The molecular switch of claim 2, wherein said molecular switch has the general molecular structure

$$\begin{array}{c} \mathrm{D} \\ | \\ X_1\!-\!Y_1\!-\!Z_1\!-\!\mathrm{R}\!-\!Z_2\!-\!Y_2\!-\!X_2 \\ | \\ \mathrm{A} \end{array}$$

where A is the acceptor group, D is the donor group, R is the rotor, X_1 is the hydrophilic moiety, X_2 is the hydrophobic moiety, Y_1 is a first stator, Y_2 is a second stator, Z_1 is a first bridging group, and Z_2 is a second bridging group.

4. The molecular switch of claim 3, wherein the hydrophobic moiety comprises a long substituted or unsubstituted hydrophobic chain having from 6 to about 30 carbons.

5. The molecular switch of claim 4, wherein the hydrophobic moiety comprises a long substituted or unsubstituted hydrophobic chain having from 8 to about 20 carbons.

6. The molecular switch of claim 4, wherein the hydrophobic moiety comprises a member selected from the group consisting of alkyl, alkoxy, alkyl thio, alkyl amino, alkyl seleno, aryl, aryloxy, aryl thio, aryl amino, aryl seleno, and combinations thereof.

7. The molecular switch of claim 6, wherein the hydrophobic moiety is an unsubstituted alkyl.

8. The molecular switch of claim 3, wherein the hydrophilic moiety is selected from the group consisting of carboxylic acid, sulfuric acid, alcohol, ethyl, polyether, tetrahydrofuran, pyridine, imidazole, pyrrole, furan, thiophene, and combinations thereof.

9. The molecular switch of claim 3, wherein the donor group is selected from the group consisting of a hydrocarbon having from one to six carbon atoms, hydrogen, amine, hydroxy, thiol, ether, and combinations thereof.

10. The molecular switch of claim 9, wherein the acceptor group is selected from the group consisting of nitro, nitrile, ketone, imine, acids, trifluoromethyl, trichloromethyl, hydrocarbons having from one to six carbon atoms, and combinations thereof, and wherein said donor group has a lower electronegativity than the acceptor group.

11. The molecular switch of claim 3, wherein the first and second bridging groups are independently selected from the group consisting of acetylene, ethylene, amide, imide, imine, azo, and combinations thereof.

12. The molecular switch of claim 11, wherein the first and second bridging groups are each acetylene.

13. The molecular switch of claim 3, wherein the first and second stators are independently selected from the group benzene or substituted benzene,

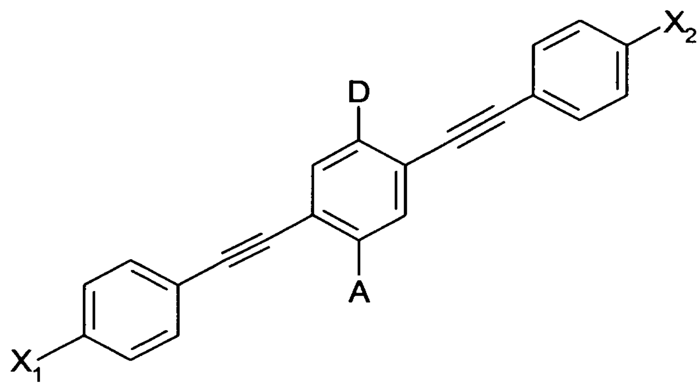
naphthalene, acenaphthalene, anthracene, phenanthrene, benzanthracene, dibenzanthracene, fluorene, benzofluorene, fluoranthene, pyrene, benzopyrene, naphthopyrene, chrysene, perylene, benzoperylene, pentacene, coronene, tetraphenylene, triphenylene, decacyclene, pyrrole, thiophene, porphine, pyrazole, imidazole, triazole, isoxazole, oxadiazole, thiazole, isothiazole, thiadiazole, pyridazine, pyrimidine, uracil, azauracil, pyrazine, triazine, pyridine, indole, carbazole, benzofuran, dibenzofuran, thianaphthene, dibenzothiophene, indazole, azaindole, iminostilbene, norharman, benzimidazole, benzotriazole, benzisoxazole, anthranil, benzoxazole, benzothiazole, triazolopyrimidine, triazolopyridine, benzselenazole, purine, quinoline, benzoquinoline, acridine, iso quinoline, benzacridine, phenathridine, phenanthroline, phenazine, quinoxaline, and combinations thereof.

14. The molecular switch of claim 13, wherein the first and second stators are each phenyl.

15. The molecular switch of claim 3, wherein the rotor comprises a member selected from the group consisting of benzene or substituted benzene, naphthalene, acenaphthalene, anthracene, phenanthrene, benzanthracene, dibenzanthracene, fluorene, benzofluorene, fluoranthene, pyrene, benzopyrene, naphthopyrene, chrysene, perylene, benzoperylene, pentacene, coronene, tetraphenylene, triphenylene, decacyclene, pyrrole, thiophene, porphine, pyrazole, imidazole, triazole, isoxazole, oxadiazole, thiazole, isothiazole, thiadiazole, pyridazine, pyrimidine, uracil, azauracil, pyrazine, triazine, pyridine, indole, carbazole, benzofuran, dibenzofuran, thianaphthene, dibenzothiophene, indazole, azaindole, iminostilbene, norharman, benzimidazole, benzotriazole, benzisoxazole, anthranil, benzoxazole, benzothiazole, triazolopyrimidine, triazolopyridine, benzselenazole, purine, quinoline, benzoquinoline, acridine, iso quinoline, benzacridine, phenathridine, phenanthroline, phenazine, quinoxaline, and combinations thereof.

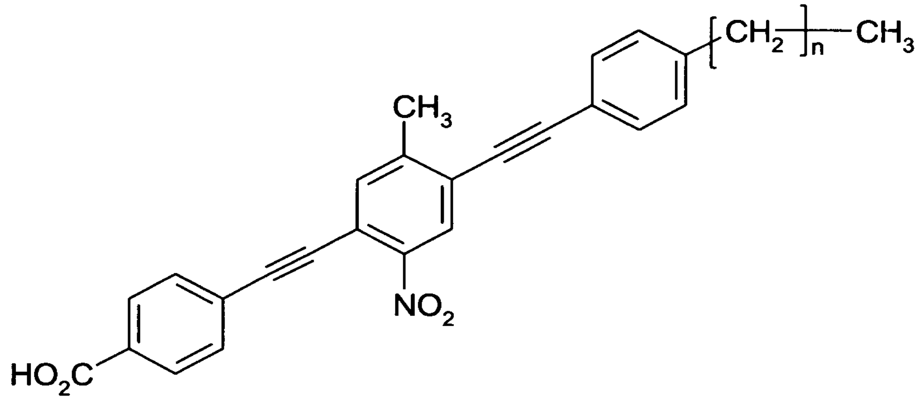
16. The molecular switch of claim 15, wherein the rotor comprises a phenyl.

17. The molecular switch of claim 3, having the chemical structure



.

18. The molecular switch of claim 3, having the chemical structure



where n is an integer from 5 to about 19.

19. A molecular switch system, comprising:

a) a substrate; and

b) a plurality of bistable molecular switches on the substrate, said molecular switches having a highly conjugated first state and a less conjugated second state such that application of an electric field reversibly switches the molecular switch from the first state to the second state, and wherein said molecular switch has a hydrophobic moiety and a

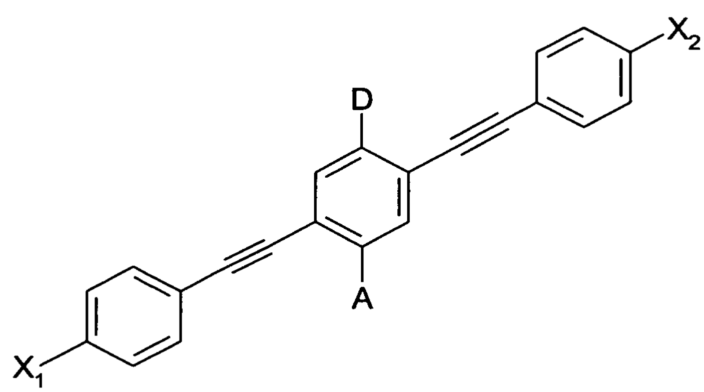
hydrophilic moiety such that substantially all of the molecular switches have the hydrophilic moiety oriented in the same direction.

20. The system of claim 19, wherein said molecular switches each further comprise at least one rotor having a donor group and an acceptor group each operably connected to the rotor to cause switching upon application of an electric field, said donor group having a lower electronegativity than the acceptor group and wherein said molecular switch has the general molecular structure

$$\begin{array}{ccccccccccccc} & & & & & & D & & & & & & \\ & & & & & & | & & & & & & \\ X_1 & - & Y_1 & - & Z_1 & - & R & - & Z_2 & - & Y_2 & - & X_2 \\ & & & & & & | & & & & & & \\ & & & & & & A & & & & & & \end{array}$$

where A is the acceptor group, D is the donor group, R is the rotor, X_1 is the hydrophilic moiety, X_2 is the hydrophobic moiety, Y_1 is a first stator, Y_2 is a second stator, Z_1 is a first bridging group, and Z_2 is a second bridging group.

21. The system of claim 20, wherein said molecular switches have the chemical structure



.

22. The system of claim 19, wherein the substrate is a conductive electrode layer.

23. The system of claim 22, wherein the conductive electrode layer comprises a material selected from the group consisting of silver, gold, copper, and alloys thereof.

24. The system of claim 22, further comprising a second conductive electrode layer such that the plurality of molecular switches is between the conductive electrode layer and second conductive electrode layer.

25. The system of claim 19, wherein the substrate has a thickness of from 1 nm to about 1.5 μm.

26. The system of claim 19, wherein the plurality of molecular switches has a thickness of from about 1 nm to about 100 nm and cover an area of the substrate of from about 0.01 μm^2 to about 0.01 mm^2.

27. The system of claim 19, wherein the plurality of molecular switches is configured in a single monolayer.

28. A method of storing data, comprising the steps of:

a) forming a molecular switch system including a layer of molecular switches between a first electrode layer and a second electrode layer, said molecular switches having a highly conjugated first state and a less conjugated second state such that application of an electric field reversibly switches the molecular switch from the first state to the second state, and wherein said molecular switch has a hydrophobic moiety and a hydrophilic moiety such that substantially all of the molecular switches have the hydrophilic moiety oriented in the same direction toward the first electrode layer; and

b) inducing an electric potential between the first and second electrode layers sufficient to switch the molecular switches from the first or second state to the second or first state, respectively.

29. The method of claim 28, wherein said molecular switches each further comprise at least one rotor having a donor group and an acceptor group each operably connected to the rotor to cause switching upon application of an electric field, said donor group having a lower electronegativity than the acceptor group and wherein said molecular switch has the general molecular structure

$$X_1 - Y_1 - Z_1 - \underset{\displaystyle A}{\overset{\displaystyle D}{\underset{|}{\overset{|}{R}}}} - Z_2 - Y_2 - X_2$$

where A is the acceptor group, D is the donor group, R is the rotor, X_1 is the hydrophilic moiety, X_2 is the hydrophobic moiety, Y_1 is a first stator, Y_2 is a second stator, Z_1 is a first bridging group, and Z_2 is a second bridging group.

30. The method of claim 28, wherein the first and second electrode layers comprise a material independently selected from the group consisting of silver, gold, copper, platinum, alumina, silicon, ITO, and alloys thereof.

31. The method of claim 28, wherein the step of inducing an electric potential occurs during a time frame of from about 1 μsec to about 10 msec.

32. The method of claim 28, wherein the electric potential is from about 1 μV to about 1000 μV per molecular switch.

33. The method of claim 28, wherein the step of forming includes using a Langmuir-Blodgett thin film technique to form at least one monolayer and orient the molecular switches.

34. The method of claim 28, wherein the molecular switch system has a thickness of from about 1 nm to about 1.5 μm.

35. The method of claim 28, wherein the first state has a first resistivity, R_1 and the second state has a second resistivity, R_2, such that R_2/R_1 is from about 2 to about 10^4.

36. The method of claim 28, wherein the layer of molecular switches is a single monolayer.